

Study on the Difference of Extraction Effect between Borehole Protecting Screen Pipe Extraction and Bare Hole Extraction in Cross-layer Boreholes

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Abstract: To effectively guide the gas extraction of cross-layer boreholes in mines, the extraction technology of borehole protecting pipe under cross-layer boreholes was studied. In this paper, by building a physical analysis model and studying the solution conditions, the influence of borehole protecting screen pipe on the extraction effect is simulated. According to the results, because the borehole protecting screen pipe can protect the extraction hole in the whole process, the pressure around the borehole is greatly reduced and the gas is extracted along the direction of hole depth with a relatively large extraction range. The data measured on site can also verify the numerical simulation results. This study provides a basis for the scientific use of borehole protecting screen pipe in gas extraction from cross-layer boreholes.

Keywords: cross-layer boreholes; borehole protecting screen pipe; bare hole; gas extraction; influence

1. Introduction

With the increasing depth of coal mining in China, the geological conditions become increasingly complicated. With the increase of high gas outburst mines, the harm of coal and gas outburst has become an important factor restricting the safety production of coal mines [1-2]. The fundamental measure to prevent and control outburst is gas extraction, and pre-extraction of coal seam gas by boreholes is the main measure to prevent and control coal and gas outburst [3-4]. The underground complex strata, especially soft coal seam or soft outburst coal seam, are easy to cause hole wall collapse and damage when drilling. Or the gas pressure may be suddenly released after accumulation, and a large number of pulverized coal particles carried will block the drilling. All these will destroy the gas extraction channel, resulting in gas extraction or reduction of extraction amount [5]. Using the screen pipe to protect the borehole can effectively avoid the failure of the borehole caused by its collapse, and keep the gas extraction channel unblocked. It has become the main measure to protect the borehole protecting wall of the underground gas extraction hole [6-8].

On-the-spot comparative tests were carried out to analyze the pure extraction amount of gas from coal seam

by borehole protecting screen pipe and bare hole in coal hole section of the coal mine in different extraction time periods, laying a good foundation for gas extraction from cross-layer boreholes in mines.

2. Design of Initial Conditions of Physical Model

Based on the 3# coal seam in a mine, combining with the process of two blocking and one injection as well as related parameters of field test, the drilling length, hole sealing length, coal seam original gas pressure, original gas content and drilling diameter were set to 50 m, 15m, 1.2MPa, 9.5m³/t and 94mm, respectively. The boundary of the calculation area was set as the dead-flow boundary, and the gas diffusion at the borehole boundary was abandoned. The boundary displacement, borehole internal stress and shear stress of the calculation area were all set to "0". The physical model of borehole gas extraction, two-dimensional model, can be transformed as the basis of simulation calculation [1]. For the coupling parameters of gas-solid coupling model of coal seam, only the porosity and permeability of coal and rock were considered, and the temperature, the coal and rock gas adsorption and desorption and the porosity of coal and rock were not considered. But the influence of gas pressure on solid skeleton must be considered. It is necessary to arrange borehole protecting screen pipes with different lengths in the borehole for extraction. The specific scheme is as follows: (1) There are no borehole protecting screen pipes in the pumping gas chamber, and the drilling gas chamber is easily affected by surrounding coal and rock factors under the action of surrounding rock stress. Therefore, the drilling gas pumping gas chamber should be set as a porous medium with high coal and rock permeability, and a constant pressure boundary should be set at the hole sealing position. (2) There is a 35m borehole protecting pipe in the gas extraction chamber, with a 29m solid pipe outside and a 6m borehole protecting screen pipe inside. For the solid pipe section, the cutoff boundary is used. There is a 15m porous protection pipe inside. In this scheme, the cutoff boundary of the solid pipe section and the boundary of the 15m borehole protecting screen pipe inside need to meet the conditions of constant pressure boundary, and the hole depth Y is within 50m/50m. (3) 15m borehole protecting screen pipe can be

seen in the gas extraction chamber. However, the borehole protecting screen pipe is not applied under the condition of surrounding rock stress, which increases the possibility of hole collapse. Therefore, it is necessary to set a

Table 1. Related parameters of coal seam

Parameter	Adsorption capacity of combustible per unit mass (m ³ /t)	Adsorption constant (MPa)	Initial gas pressure (MPa)	Mass of combustible in unit volume coal (Kg/m ³)	Initial porosity (%)
Numerical value	18.3	0.98	1.2	1130	2.25
Parameter	Diffusion coefficient (m ² /s)	Elastic modulus (Pa)	Poisson's ratio	Gas dynamic viscosity (Pa s)	Original coal seam permeability (m ²)
Numerical value	7×10^{-12}	3×10^9	0.5	1.11×10^{-5}	2.7×10^{-16}

3. Influence of Borehole Protecting Screen Pipe on Gas Extraction in Cross-Layer Boreholes

It can be seen from the numerical simulation results that: after 40 days of gas extraction, the pressure distribution around the borehole is balanced, and the gas pressure at the far end of the borehole is close to the original gas pressure. There is a strong correlation between the position of the extraction hole of the borehole protecting screen pipe and the borehole gas extraction effect. The gas pressure around the borehole decreases, and the gas pressure around the exit boundary decreases significantly. The gas pressure distribution around the borehole shows a drop shape. The borehole protecting screen pipe can provide full-course protection for the extraction borehole. The pressure around the borehole decreases significantly. The gas is drained along the direction of the borehole depth, with a relatively large extraction range and oval distribution shape. In addition, the attenuation of negative pressure in the hole is not obvious along the drilling direction.

4. Discussion on Field Test Process and Results

Extraction from 3# coal seam was carried out by cross-layer boreholes, and the influence of different extraction time on the gas content distribution in the coal around the hole protecting screen pipe borehole and bare hole was studied. Coal seam gas content was treated by the direct underground measurement method, and tested by the coal seam gas content reduction method. A reasonable location layout was made in the 3317 floor rock roadway of coal mine, and three groups were respectively set for the borehole protecting screen pipe extraction and the bare hole extraction. After 15m hole sealing, the gas content of surrounding coal after 30 days, 50 days and 70 days of extraction was compared. After 30 days, 50 days and 70 days of extraction, the residual gas content of coal was measured by sampling at 3m-5m, 3m-6m and 3m-7m boreholes, respectively. The results showed that under the same extraction time, the gas content in the coal around the borehole protecting screen pipe group was obviously lower than that of the bare hole group. The longer the extraction time, the more obvious the difference. The reason is that the borehole protecting screen pipe can provide extraction space for boreholes, while the screen holes on the screen can provide a path for gas extraction; for the bare hole group, due to high ground stress and coal

reasonable constant pressure boundary at the hole sealing position, as shown in Table 1.

creep, the boreholes are blocked, causing larger gas flow resistance.

5. Conclusion

Attention should be paid to the fact that when gas is extracted through borehole protecting screen pipe from cross-layer boreholes, the contour lines of gas pressure and content around the borehole are oval, and the gas pressure and content around the borehole are effectively controlled. Therefore, the reasonable use of borehole protecting screen pipe in the cross-layer boreholes for extraction can improve the overall extraction effect by prolonging the extraction time. On the contrary, the gas content and the pressure decrease will not significant without using borehole protecting screen pipe, which will have an adverse effect on the gas extraction effect to a certain extent.

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